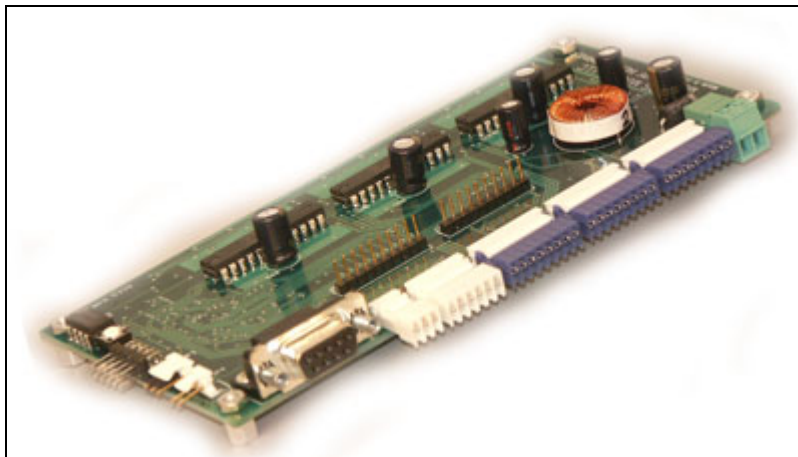


R364 3-Axis Controller/Driver



User Manual – 2 of 2
Commands Guide

Version 2.33

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Table of Contents

COMMAND TABLES	3
Basic Configuration Commands.....	4
Axis Configuration Commands	4
General Operation Commands.....	4
Position Move Commands	5
Velocity Move Commands	5
R364 PARAMETER USAGE DIAGRAM.....	6
Axis Active.....	7
Analog Channel.....	8
Acceleration Current (I)	9
Axis Status	10
Acceleration Threshold	11
Acceleration maXimum	12
Baud Selector	13
Bit Direction	14
Current Position	15
Current Velocity.....	16
Digital In	17
Digital Out	18
Full Duplex	19
Home Axis	20
Hold Current (I)	21
Interrupt Flags	22
Interrupt Mask	23
Interpret Velocity	24
Joystick Active.....	25
Load Defaults	26
Linear Go.....	27
Linear Interpret.....	28
Lower Limit	29
Module Address	30
Multi-Axis Go	31
Multi-Axis Move	32
Pulse Divisor	33
Phase Current (I)	34
Position Target	35
Reference Configuration	36
Ramp Divisor	37
Run Current (I)	38
Reference Tolerance	39
Stop Axis	40
Save Data	41
Step Resolution	42
Soft Stop	43
Upper Limit.....	44
Velocity miNimum	45
Velocity Target	46
Velocity maXimum.....	47
Zero Offset	48

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COMMAND TABLES

General

All commands start with the '#' character and a single alpha module address. Then a two-letter command code followed by a single letter denoting the applicable axis. Next a context dependent value qualifier in the form of a hexadecimal character string.

#<address><command><axis><value><cr><lf>

The command is terminated by the <carriage return><linefeed> character pair. Spaces or other punctuation characters are not allowed in the command character sequence.

Command responses use the same format, except the first character with the '*' character

***<address><command><axis><value><cr><lf>**

To query a current parameter value, the command is sent without a value qualifier.

The default module or board address is 'A', Addresses in the range 'A' to 'Z' are valid.

Axis selection is by the 'X', 'Y', 'Z', and 'G' characters, where 'G' is used for all general commands.

Half-Duplex communication must be used for RS485, and Full-Duplex is optional for RS232

Note: The position of a jumper on module must also be changed to select between the RS232 and RS485 mode of communications.

TRUE/FALSE conditions use the values 1 = TRUE and 0 = FALSE.

The default baud rate is 57,600. With 8 data bits, 2 stop bits, no parity and no handshake.

Basic Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Baud Select	Q/N	BS	Numeric	3	191	7 (Table)
Bit Direction	N	BD	Binary	0	11111111	11111111
Full Duplex	Q/N	FD	Two Digits	00	11	1 0
Load Defaults	N	LD	None	-	-	-
Module Addr	Q/N	MA	Alpha	A	Z	A (0x41)

Axis Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Axis Active	Q/N	AA	Boolean	0	1	1 (TRUE)
Accel Current	Q/N	AI	Numeric	0	7	0 = 8/8th
Accel Thresh	Q/N	AT	Numeric	0	2047	40
Accel Max	Q/N	AX	Numeric	0	2047	1024
Hold Current	Q/N	HI	Numeric	0	7	1 = 1/8th
Interrupt Flags	Q	IF	Binary	0	11111111	0
Interrupt Mask	Q/N	IM	Binary	0	11111111	0
Lower Limit	Q/N	LL	Numeric	0	16777215	0
Pulse Divisor	Q/N	PD	Numeric	0	15	4
Phase Current	Q/N	PI	Numeric	0	255	68
Ramp Divisor	Q/N	RD	Numeric	0	15	10
Run Current	Q/N	RI	Numeric	0	7	7 = 7/8th
Ref Configure	Q/N	RC	Numeric	0	15	0
Ref Tolerance	Q/N	RT	Numeric	0	4095	0
Step Resolution	Q/N	SR	Numeric	0	7	4
Upper Limit	Q/N	UL	Numeric	0	16777215	16777215
Velocity Min	Q/N	VN	Numeric	0	2047	1
Zero Offset	Q/N	ZO	Numeric	-16777215	0	0

General Operation Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Analog Chan	Q	AC	Chan No	0	7	0
Axis Status	Q	AS	Boolean	0	4095	-
Current Posn	Q/N	CP	Numeric	0	16777215	-
Current Vel	Q	CV	Numeric	0	4095	-
Digital In	Q	DI	Binary	0	11111111	-
Digital Out	N	DO	Binary	0	11111111	0
Home Axis	N	HA	Axis	X	Z	-
Joystick Active	Q/N	JA	Axis	0	1	0
Stop Axis	N	SA	Axis	G	Z	-
Save Data	N	SD	None	-	-	-

Position Move Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Linear Interpolate	N	LI	Two Digits	13	26	-
Linear Go	N	LG	None	-	-	-
Velocity Max	Q/N	VX	Numeric	0	2047	1024
Position Target	Q/N	PT	Numeric	-16777215	16777215	0
Multi-Axis Move	N	MM	Two Digits	0	07	-
Multi-Axis Go	N	MG	None	-	-	-
Stop Axis	N	SA	None	-	-	-

Velocity Move Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Velocity Target	Q/N	VT	Numeric	0	+/-2047	0
Multi-Axis Move	N	MM	Two Digits	0	27	-
Multi-Axis Go	N	MG	None	-	-	-
Stop Axis	N	SA	None	-	-	-

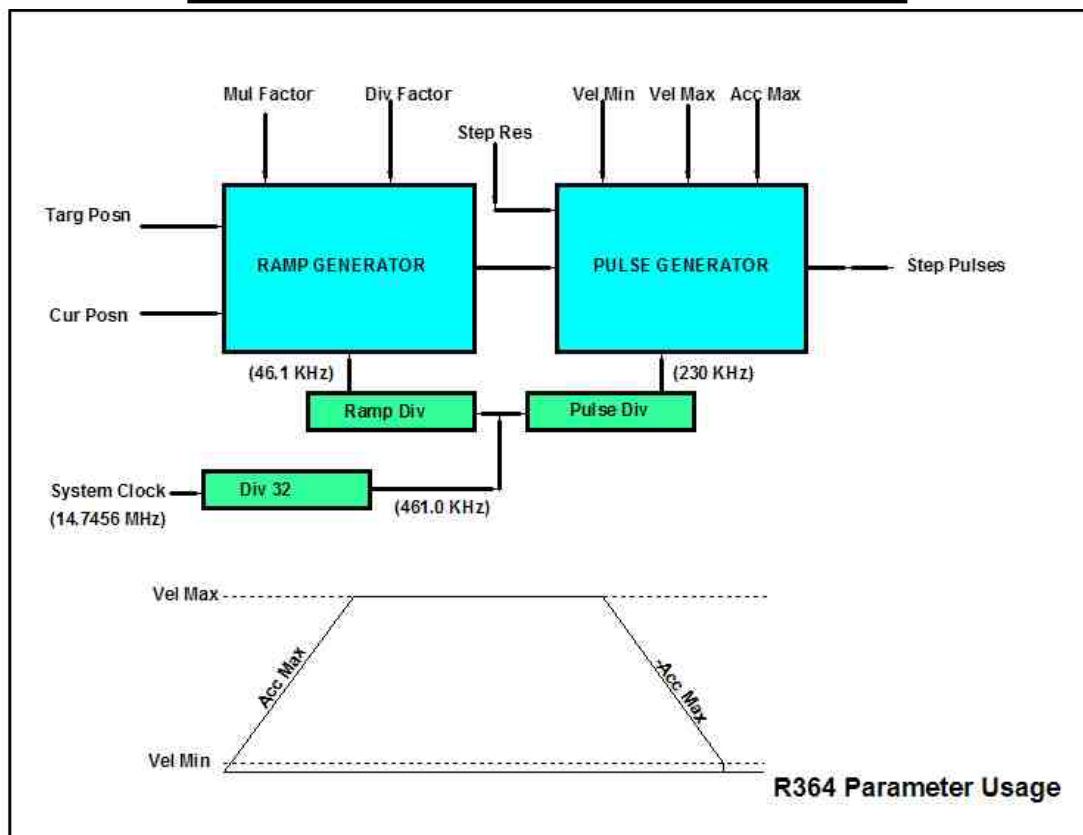
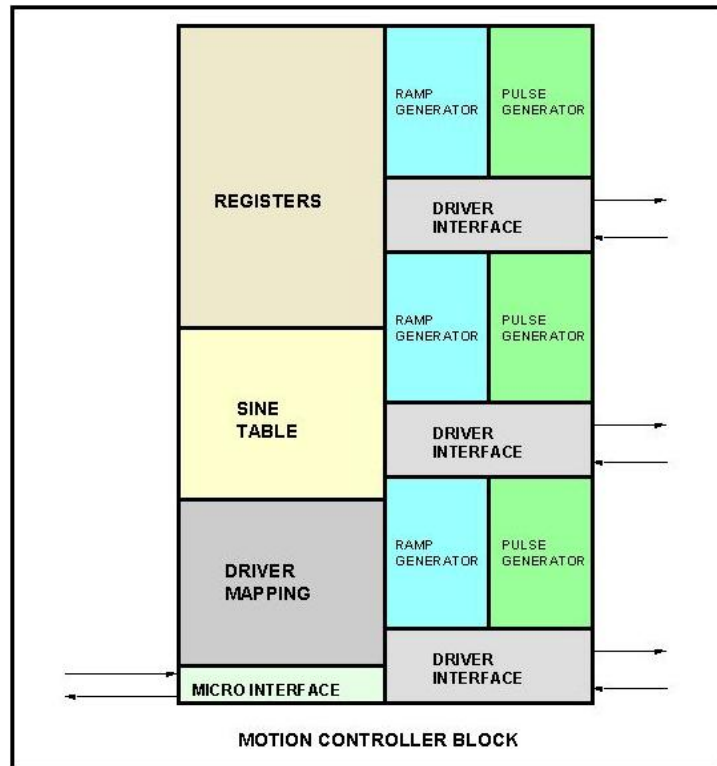


Figure 1: R364 Parameter Usage Diagram

Axis Active

Command Only or Query TRUE(1) or FALSE(0).

Only applicable to the X (Motor 1), Y (Motor 2), and Z (Motor 3) axis.
Not to G, the axis alpha used for General commands

When an axis is set inactive then the phase current for the motor is set to zero. If subsequently the axis is set active, then the phase current for the motor must be set using the PI command.

Command Example

`#AAAX1<cr><lf>` Sets X axis active.

Default value is 1

A nalog C hannel

Command Only – Axis G Value = Channel No

Returns a 10 bit unsigned value, corresponding to 0 to 5V (See Note), in hex notation for the input to the selected channel.

Command Example

```
#AACG3<cr><lf>
```

Note:

The full-scale reading of 1023 will correspond to the actual value of the Analog 5VDC supply as measured between pins 1 and 2 of connector J6. If the supply is exactly 5 VDC then a reading of 1 = $5,000/1024 = 4.88$ mV

Acceleration Current (I)

Command or Query – Value Range 0 to 7

Command Example

```
#AAIX7<cr><lf>
```

Sets the fraction of the motor Phase Current (I_{ph}) used during acceleration and deceleration.

The velocity range for Acceleration Current (I_{ac}) is set by the Acceleration Threshold (A_{th}) value

Default value is 0 = (100% or 8/8th)

Fraction	Value
8/8 (100%)	0
7/8	7
6/8 (3/4)	6
5/8	5
4/8 (1/2)	4
3/8	3
2/8 (1/4)	2
1/8	1

Axis Status

Query Only – No Value

Only applicable to the X (Motor 1), Y (Motor 2), and Z (Motor 3) axis.
Not to G, the axis alpha used for General commands. Two digits are used to represent Axis Status, and two digits for Switch Status.

Command Example

```
#AASX<cr><lf>
```

Response

```
*AASX15,07<cr>,<lf> Status = 15 Switches = 7
```

The command returns two values each representing an 8 bit sets of Flags

Status (First digit pair)

MSB (7) Interrupt Flag (Cleared by IF command)

Bit 6	Datagram Waiting
Bit 5	Ref Switch Tripped Z
Bit 4	Z at Target Position
Bit 3	Ref Switch Tripped Y
Bit 2	Y at Target Position
Bit 1	Ref Switch Tripped X
LSB (0)	X at Target Position

Switches (Second digit pair)

MSB (7)	Not Used
Bit 6	Not Used
Bit 5	Z Left Limit Switch
Bit 4	Z Right Limit Switch
Bit 3	Y Left Limit Switch
Bit 2	Y Right Limit Switch
Bit 1	X Left Limit Switch
LSB (0)	X Right Limit Switch

Acceleration Threshold

Command or Query – Value Range 0 to 2047

Command Example

#AATX7<cr><lf>

Sets the acceleration value at which the motor current changes from Acceleration Current (Iac) to Run Current (Icv) during acceleration and from Run Current (Icv) to Acceleration Current (Iac) during deceleration.

The units are the change in velocity per time unit / 256 with time unit being set by the Ramp Divisor

Default value is 40

Acceleration maXimum

Command or Query – Value Range 0 to 2047

Command Example

`#AAXX40<cr><lf>`

Sets the acceleration limit. The units are the change in velocity per time unit / 256 with time unit being set by the Ramp Divisor

Default value is 512

Baud Selector

Command or Query – Value Range (see table)

Command Example

#ABSG7<cr><lf>

Sets the RS232 and RS485 operating baud rate

The communication parameters are fixed at eight data bits, one stop bit, no parity, and no handshaking.

The RX buffer size is only 32 bytes, so the host software must control the message rate to prevent buffer over-run.

RS232 communication uses full duplex, and RS485 uses half-duplex.

For RS485 messaging, transmission direction is switched one character interval after receipt of the <lf> character and transmission is started in the other direction one-character interval after the direction change.

The host message start character is '#' (0x23) and the module response start character is "*" (0x2B)

Default selector value is 7 (57,600 Baud)

Baud	Selector
115,200	3
76,800	5
57,600	7
38,400	11
28,800	15
19,200	23
14,400	31
9,600	47
4,800	95
2,400	191

Bit Direction

Command or Query – Binary Value 0 – 11111111

The Logic Level port at J7 is by default an 8 bit output port; however individual bits can be made inputs by setting the corresponding bits in the value byte used by this command to zero and read by the response to the Digital Out (DO) command.

Command Example

#ABDG01111111<cr><lf> Bit 0 set to input

Default value is 11111111 All outputs

Current Position

Command or Query – Value Range 0 to 16777215

Normally used to poll the current axis position, but can be used to change the value of the current location.

Note: If the current position is change while in the Ramp Profile mode, you will redefine the target location. This is automatically corrected by the firmware.

Command Example

`#ACPX<cr><lf>`

Current Velocity

Query – Value Range 0 – +/-2047

Normally only used to poll the current axis velocity.

Command Example

#ACVX<cr><lf>

Digital In

Query – Binary Value 0 – 11111111

Used to read the Analog Input port (J6) as logic levels

Command Example

`#ADIG<cr><lf>`

Digital Out

Command and Query – Binary Value 0 – 11111111

Used to write the Digital Output port (J7), and if some of the port bits are set to be inputs with the Bit Direction command, read the inputs mixed with the outputs as logic levels

Command Example

```
#ADOG01101111<cr><lf>
```

Sets bits 0,1, 2, 3, 5, 6 high and bits 4 and 7 low

Full Duplex

Command only – 0, 1,10, 11 Only valid values

Full Duplex is used only for direct user control via Hyperterm and RS232. For application software control via RS232, and RS485 Half-Duplex (Not Full-Duplex) is normally used

Command Example

#AFDG1<cr><lf> Full-Duplex On

This command can also be used to turn on Debug in which the actual messages sent to the Motion Controller are seen.

A second leading digit (0 is Off and 1 is On) is used to control Debug

Command Example

#AFDG11<cr><lf> Full-Duplex and Debug On

Default is 00 = Debug Off and Full Duplex Off. The set value is remembered over power cycles.

Home Axis

Command only – No value

Command Example

`#AHAX<cr><lf>`

Uses a Velocity Profile move to find the left limit switch. Then makes a position move away from the limit switch by the amount of the Zero Offset. At the end of this move the current position is set to be zero.

Hold Current (I)

Command or Query – Value Range 0 to 7

Command Example

#AHIX7<cr><lf>

Sets the fraction of the motor Phase Current (I_{ph}) used between moves when velocity is zero.

Default value is 1 = (1/8th)

Fraction	Value
8/8 (100%)	0
7/8	7
6/8 (3/4)	6
5/8	5
4/8 (1/2)	4
3/8	3
2/8 (1/4)	2
1/8	1

Interrupt Flags

Query – Binary Value 0 – 11111111

Flags are only set if both the associated event has occurred and the corresponding bit in the Interrupt Mask is set.

Command Example

```
#AIFG<cr><lf>
```

MSB (7)	Stop with Right High
Bit 6	Stop with Left High
Bit 5	Stop with Right Low *
Bit 4	Stop with Left Low *
Bit 3	Stop by Limit Switch
Bit 2	Limit/Reference Switch missed *
Bit 1	Limit/Reference Switch wrong *
LSB (0)	Position End of Range reached

Not applicable with standard Limit Switch configuration

Interrupt Mask

Command or Query – Binary Value 0 – 11111111

Mask bits enable the corresponding flag bits to be set when the associated event occurs.

Command Example

#AIMX11001001<cr><lf> Bits 0, 3, 6, and 7 set

MSB (7)	Stop with Right High
Bit 6	Stop with Left High
Bit 5	Stop with Right Low *
Bit 4	Stop with Left Low *
Bit 3	Stop by Limit Switch
Bit 2	Limit/Reference Switch missed *
Bit 1	Limit/Reference Switch wrong *
LSB (0)	Position End of Range reached

Not applicable with standard Limit Switch configuration

Default value is 0

Interpret Velocity

Command or Query – Value Range 0 to 2047 (Default 100)

Sets the path velocity to be used by either Linear or Circular Interpolation.

Command Example

```
#AIVG400<cr><lf>
```

Default value is 400

Joystick Active

Command or Query – TRUE (1) or FALSE (0)

The Analog Input port is used to connect a CH C40009IF-MJ4 3-axis joystick with four push-buttons.

Command Example:

#AJAG1<cr><lf> sets joystick active

Default value is 0 FALSE

Load Defaults

Command only – No Value

Used to restore all parameters to their factory default values. To store the values in EEPROM this command should be followed by a Shut Down command

Command Example

```
#ALDG<cr><lf>
```

See page xx for a list of default values

Linear Go

Command Only – No Value

Only valid if preceded by a Linear Interpolate (LI) command and the target position coordinates have been entered.

Command Example

```
#ALIG07<cr><lf> Linear interpolate a ramp profile for X, Y, Z  
#APTX1000<cr><lf> Set target position X to 1000  
#APTY1000<cr><lf> Set target position Y to 1000  
#APTZ1000<cr><lf> Set target position Z to 1000  
#ALGG<cr><lf> Linear Go
```

Linear Interpret

Command Only – Value is two digits

Digit 1 (MSD)

0 = Ramp Move

1 = Soft-stop Move

3 = Velocity Move

Digit 2 (LSD)

3 = ZY move

5 = ZX move

6 = XY move

7 = XYZ move

Command Example:

```
#ALIG07<cr><lf> Linear interpolate a ramp profile for X, Y, Z
#APT X1000<cr><lf> Set target position X to 1000
#APT Y1000<cr><lf> Set target position Y to 1000
#APT Z1000<cr><lf> Set target position Z to 1000
#ALGG<cr><lf> Linear Go
```

Lower Limit

Command or Query – Value Range 0 to 16777215

Sets the software-controlled range of motion for the axis, to be between the Lower and Upper Limit values. If the Current Position becomes out of range when the Limit is set, the motor will move to the new limit value.

Note: If the limit is reached via a velocity move, a HARD STOP will occur.

Command Example

```
#ALLX200 <cr><lf>
```

Default value is 0

Module Address

Command or Query – Value Range 'A' to 'Z'

Assigning modules different addresses allows multiple modules to be run on a common RS485 Bus. The default address is 65 = 'A'

Returns and accepts the decimal ASCII value of the character.

Command Example

#AMAG65<cr><lf> Sets the default address A

Multi-Axis Go

Command only – No value

Only valid if proceeded by a Multi-Axis Move (MM) command. Starts a Ramp or Velocity move of up to three axis.

Command Example

```
#AMMG07<cr><lf> Three axis, ramp profile move.  
#APTX1000<cr><lf> Set target position X to 1000  
#APTY1000<cr><lf> Set target position Y to 1000  
#AMGG<cr><lf> Multi-axis Go
```

Multi-Axis Move

Command only – Two Digits

Precedes the entry of Target Positions, or Target Velocities for a simultaneous multiple axis movement.

Command Example

```
#AMMG07<cr><lf> Three axis, ramp profile move.  
#APT X1000<cr><lf> Set target position X to 1000  
#APT Y1000<cr><lf> Set target position Y to 1000  
#AMGG<cr><lf> Multi-axis Go
```

Only five bits of the value are valid

First Digit (MSD)

Move Profile selector 0 = Ramp, 1 = Soft Stop, 2 = Velocity

Second Digit (LSD)

Represents a 3 bit binary value where

Bit 2 X axis involved

Bit 1 Y axis involved

Bit 0 Z axis involved

Target Position or Velocity commands for the involved axis that are entered after this command will be held back until a Multi-Axis Go command is entered.

Command is modal (remains in effect until cancelled)

#AMMGO<x> cancels command

Pulse Divisor

Command or Query – Value Range 0 – 15

Used to set the update interval of the Pulse Generator.

Command Example

```
#APDX2<cr><lf>
```

Default value is 4

Phase Current (I)

Command or Query – Value Range 0 – 255

Used to match the Driver Phase Current with the motor rated current. Only valid over the range 0.2 Amp/Phase to 1.5 Amp/Phase. The value 255 corresponds to 1.5 Amp. So for any other current I_{ph} the value is:

$$255 \times I_{ph}/1.5 \text{ or } I_{ph} \times 170$$

Command Example

#APIX128<cr><lf> Phase Current 0.75 Amps

Note: It is good practice to enter a value not greater than 80% of the motor rating to maximize motor life.

Default value is 171 (1Amp)

Position Target

Command or Query – Value Range -1677215 to 16777215

Sets the target position for Ramp Profile moves.

Command Example

#APTX2047<cr><lf>

Reference Configuration

Command or Query – Value Range 0 to 15 (Default 0)

Allows automatic stopping on limit switch action to be enabled or disabled. Also allows the stop mode 'Soft' or 'Hard' to be selected, and either the right or left switch to be the reference.

Function	Bit	Value
Stop Left	0	1 = Disable
Stop Right	1	1 = Disable
Soft Stop	2	1 = Enable
Right/Left	3	1 = Right

Command Example

#ARCX4<cr><lf> Turns on Soft Stop

Default value is 0

Ramp Divisor

Command or Query – Value Range 0 – 15

Used to determine the acceleration update interval during ramp action.

Command Example

```
#ARDX10<cr><lf>
```

Default value is 10

Run Current (I)

Command or Query – Value Range 0 to 7

Command Example

#ARIX7<cr><lf>

Sets the fraction of the motor Phase Current (Iph) used during moves when velocity is constant.

Default value is 7 = (7/8th)

Fraction	Value
8/8 (100%)	0
7/8	7
6/8 (3/4)	6
5/8	5
4/8 (1/2)	4
3/8	3
2/8 (1/4)	2
1/8	1

Reference Tolerance

Command or Query – Value Range 0 to 4096 (Default 0)

When a limit switch is used as a 'Reference Switch' Reference Tolerance can be used to inhibit interrupts from the switch over a +/- range about the nominal position.

Command Example

```
#ARTX4<cr><lf>
```

Default value is 0

Stop Axis

Command only – No value

Stops motion on the selected axis, or all axis if the 'G' axis value is used. For velocity profile moves, this is done by setting the target velocity to zero, resulting in a ramped stop. For ramp moves, the target position is set to be the same as the current position, resulting in an abrupt stop without a ramp.

Command Example

```
#ASAG<cr><lf> Stops all axis
```


Save Data

Command only – No value

This command results in all current parameter values, including the current position of each axis, being stored in EEPROM. A flag is set in EEPROM that will cause the current position values to be restored on power up, providing that Save Data is the last command received before power down.

Command Example

```
#ASDG<cr><lf>
```

Step Resolution

Command or Query – Value Range 0 to 7

Sets the step resolution and the count units for all position parameters.

Command Example

#ASRX4<cr><lf> Selects 16X Microsteps

Resolution	Value
Full Step	0
Half Step	1
4X μ Step	2
8X μ Step	3
16X μ Step	4
32X μ Step	5
64X μ Step	6
64X μ Step	7

Default value is 4 (16X)

Soft Stop

Command or Query – TRUE (1) or FALSE (2)

Determines if Softstop is to be used in place of the default ramp move for an axis.

Command Example:

#ASSX1<cr><lf> Sets Softstop TRUE for x axis

Default value is 0

Upper Limit

Command or Query – Value Range 0 to 16777215

Sets the software-controlled range of motion for the axis, to be between the Lower and Upper Limit values. If the Current Position becomes out of range when the Limit is set, the motor will move to the new limit value.

Note: If the limit is reached via a velocity move, a HARD STOP will occur.

Command Example

```
#AULX8000000<cr><lf>
```

Default value is 16777215

Velocity miNimum

Command or Query – Value Range 0 to 2047

Sets the end-of-ramp down minimum velocity. Must be set to one to ensure exact target position.

Command Example

```
#AVNX1<cr><lf>
```

Default value is 1

Velocity Target

Command or Query – Value Range 0 to +/-2047

Sets the constant velocity speed for Velocity Profile moves.

Command Example

#AVTX<cr><lf>

Velocity maXimum

Command or Query – Value Range 0 to 2047

Sets the constant velocity speed for Ramp Profile moves.

Command Example

```
#AVXX1024<cr><lf>
```

Default value is 358

Zero Offset

Command or Query – Value Range -16777215 to 0

Used by the Home Axis command, this parameter value sets the distance between the Left Limit Switch and the zero position location.

Command Example

#AZOX-500<cr><lf>

Default value is 0